Production of hybrid corn under doses of bovine manure

Jhansley Ferreira Mata[1], Josianne Cardoso Da Silva[2], Jaiza Francisca Ribeiro[3], Flávio Sérgio Afférri[4], Leciany Márcia Vieira

Abstract

This work aimed at evaluating the production of hybrid corn under different levels of fertilization with bovine manure. The work was conducted in the experimental station of the Academical Campus of Gurupi of the Federal University of Tocantins. The experimental design used was in randomized blocks (RBD), with six replications. Each block was composed by eight treatments: 0, 10, 20, 30, 40, 50, 60 t ha^{-1} of organic fertilizer (tanned bovine manure) and chemical fertilizing with 500 kg ha^{-1} of 4-14-8 + Zn. The simple hybrid corn was used DAS655, on a Latossolo Vermelho-Amarelo Distrófico típico (EMBRAPA, 2006). The appraised parameters were: height, diameter of the stem, number of leaves, height of the base of the first corn ear, number of leaves above the first corn ear, number of ramifications of the tassel, angle of the tassel, angle of the third leaf, length of the tassel, number of grain rows, number of grains per rows, diameter of the ear of corn, length of the ear of corn, dry matter of the plant and leaf area. The organic fertilization influenced significantly in the height of initial plant, diameter of the stem, number of leaves, leaf area and diameter of the ear of corn of the culture of the corn. The application of the tanned bovine manure in the planting furrow can substitute the chemical fertilization, without committing the performance of the culture for the forage production.

Key-words: *Zea mays* L., alternative manuring, organic manuring.

Introduction

Maize (*Zea mays*) is an annual culture that has been widely used as subsistence culture in Brazil, and it is considered one of the most important products to the country man. Besides being used as food, it is also indispensable for the creation of birds and swine, being an important product of the national economy. Nowadays, Brazil is one of the largest producers of this grain in the world, which is produced in a large scale, although the production is not enough to achieve the internal market demand (INACIO, 2011).

In the North region of Brazil, the maize cultivation has increased over the years (IBGE, 2010). However, the low productivity is connected mainly to the climate changes, which occurs in Tocantins, where several factors affect the development of the maize culture, as nitrogen fertilization, spacing variety and temperature. The maize appropriated association of these factors may provide yields favorable to the culture.

The continuous use of chemical fertilizers in a non-controlled way has caused serious problems of soil degradation, since it causes a quick reduction in the content of organic matter, salinization, erosion and impoverishment of nutrients of the soil solution over the years (SILVA et al., 2007).

Techniques of recovery of the degraded soil trough the organic fertilization may enable the return to the conditions of ecological balance which come to reduce significantly, or, even, eliminate the use of chemical fertilizers in the productive system. The use of the organic compound has been one of the most used alternatives of soil fertilization and plant nutrition in the rural mean in substitution to the chemical fertilizers (SOUZA, 1998).

The maize crop in Brazil may be organically produced and achieve, medium to long term, either the national or the international market of certified

Received on: 15 feb. 2010. Accepted for publication on: 12 may 2010.

1 Prof. MSc. couse of Agronomy, UEMG Campus de Frutal, Av. Prof. Mário Palmério, 1001, Bairro Universitário, CEP 38200-000, Frutal-MG, e-mail: jhansley@agronomo.eng.br.

2 Student of Doctor's degree in Agronomy. UFG, Campus Samambaia, Rodovia Goiânia/Nova Veneza, Km 0, CEP: 74.001-970, Goiânia – GO, e-mail: josy@uft.ed.br.

3 MSc. in Vegetal Production, UFT. e-mail: jafra@uft.edu.br.

4 Prof. Dr. Course of Agronomy, UFT Campus de Gurupi, Rua Badejós, chácaras 69 e 72 Lt.07 - Zona Rural, Cx.postal 66 - CEP: 77404-970, Gurupi – TO, e-mail: flavio@uft.edu.br.

organic products. For this, it must be used organic compounds as one alternative of soil fertilization and plant nutrition in substitution to the chemical fertilizers (SOUZA, 1998).

The bovine manure is one of the organic residues with higher potential of use as fertilizer, mainly by small farmers. However, it is little known about the quantities that should be applied, which enables the obtaining of satisfactory yields in the production and improvement in the seed quality (ALVES et al., 2005), since several factors affect the physiological quality of seeds, among them, the fertilization management.

The efficient management of manure and organic waste to the fertilization of agricultural crops requires the knowledge of the dynamics of nutrient mineralization, aiming to optimize the synchronization of the availability of nutrients in the soil with the culture demand, avoiding the immobilization or fast mineralization of nutrients during the periods of high or low demand (MYERS et al., 1994; HANDAYANTO et al., 1997).

Facing this, the objective of this work was to evaluate the production of hybrid maize under different levels of fertilization with cattle manure.

Material and methods

The work was conducted in the experimental field of the Universidade Federal do Tocantins (Federal University of Tocantins) – University Campus of Gurupi, south region of Tocantins, in climate of the type AW-tropical, of humid summer and period of draught in the winter (KÖPPEN, 1948), with annual average temperature of 29.5 °C and annual average rainfall of 1 804 mm as it was shown in Figure 1.

The experiment was installed on March 6, 2009, with seeding of the maize hybrid DAS655 simple, over a Latossolo Vermelho-Amarelo Distrófico típico, with the following characteristics: pH ($CaCl_2$): 5.0; Ca: 2.5 $cmol_c$ dm^{-3}; Mg: 0.7 $cmol_c$ dm^{-3}; Al: 0.0 $cmol_c$ dm^{-3}; Al+H: 3.3 $cmol_c$ dm^{-3}; P (mel): 32.5 mg dm^{-3}; P (resin): 41.0 mg dm^{-3}; K: 85.0 mg dm^{-3}; Cu: 0.7 mg dm^{-3}; Zn: 5.8 mg dm^{-3}; Fe: 490.0 mg dm^{-3}; Mn: 44.6 mg dm^{-3}; CEC: 6.72 $cmol_c$ dm^{-3}; V: 50.96%; O.M.: 0.9%.

The experiment design used was randomized blocks (RBD), with six replications. Each block was composed by eight treatments, being the following levels of fertilization: 0, 10, 20, 30, 40, 50, 60 t ha^{-1}

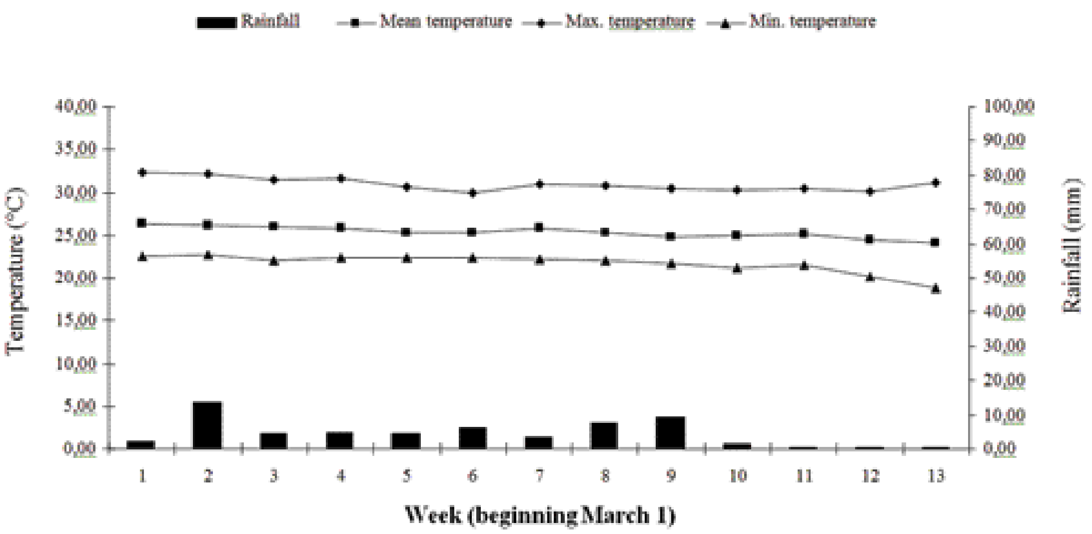

Figure 1. Average rainfall of the agricultral year 2009 in the Fundation Universidade Federal do Tocantins (Federal University of Tocantins) – University Campus of Gurupi, southwest region of the state of Tocantins. INEMET/UFT.

of organic fertilizer (cattle manure in the period of 60 days before the maize seeding) with the following characteristics: pH ($CaCl_2$): 6.9; Ca: 4.0 $cmol_c$ dm^{-3}; Mg: 2.3 $cmol_c$ dm^{-3}; Al: 0.0 $cmol_c$ dm^{-3}; Al+H: 0.4 $cmol_c$ dm^{-3}; P: 683.0 mg L^{-1}; K: 103.1 mg L^{-1}; Na: 33.8 mg L^{-1}; O.M.: 7.3%; and chemical fertilization with 500 kg ha^{-1} of 4-14-8 + Zn. Each treatment was composed by a row with two meters with ten plants per linear meter and spacing between treatments of one meter.

The plague control was performed with the use of cow urine (5%).

The parameters evaluated were: height: measure of the plant height weekly from the soil until the curvature of the last leaf with scale graduated in cm; diameter of the stem: weekly measure of the stem 20 cm from the soil with a caliper; number of leaves: weekly count of the number of leaves which were completely opened; height of the base of the first ear: measure from the soil until the point of intersection of the first ear with a scale graded in cm; number of leaves above the first ear; number of ramifications of the tassel; angle of the tassel: measure of the angle of the tassel with a protractor; angle of the third leaf: measure of the angle of the third leaf with a protractor; length of the tassel: measure of the base of insertion of the tassel in the plant until the point of the tassel with a scale graded in cm; number of grain rows; number of grains per rows; diameter of the ear: measure of the diameter with a caliper; length of the ear: measure of the length with a scale; plant dry matter: leaf area: measure of the length and of the width of the leaf, with the use of the equation L x W* 0.75, in which L = leaf length, w = leaf width (FRANCIS et al., 1969).

The data were submitted to the analysis of variance, evaluating the differences between the averages trough the Regression, the adjustment of the models were made based on its significance and the coefficient of determination (R^2), based on the recommendations of VENEGAS and ALVAREZ (2003), using the statistic program Microcal Origin 6.1., and the Tukey test at 5% probability, using the statistic program SISVAR (FERREIRA, 2003).

Results and discussion

In Figure 2 it can be observed the maize plant height evaluated weekly.

It can be seen that the dose of 60 t ha^{-1} of the

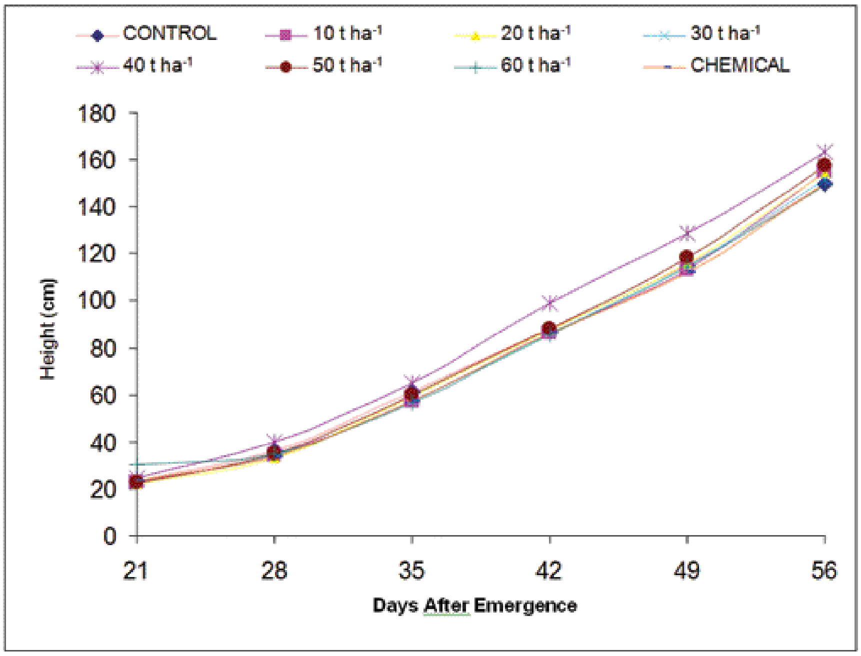

Figure 2. Maize plant height in function of doses of organic and chemical fertilization.

organic fertilization contributes to a higher initial plant height (21 DAE). This result is confirmed by the interception of the equations for the same dose (Table 1). However, from this period, the dosed which demonstrated to be the most efficient for this characteristic was 40 t ha^{-1}, favoring a height of 163 cm 56 DAE (Figure 2) and higher daily increment according to the linear coefficient of the equation (Table 1). In the other treatments there was no differentiation. VALENTINI et al. (2003), when evaluating organic fertilization in sweet corn, verified that dosed of 30 t ha^{-1} favored higher plant height in the cultivars DINA 170 and DINA 270 and GOMES et al. (2005), when comparing the chemical fertilization with the organic, found that the latter provided higher values of height in the maize crop.

In Figure 3 it can be observed the evolution of the diameter of the stem weekly evaluated. Initially, there was a fast growth for all the doses until the 28 DAE. After this period, the plant minimized the speed of growth. The dose of 40 t ha^{-1} provided higher initial diameter (Figure 3), due to the higher daily increment verified in the linear coefficient of the equation, in relation to other treatments (Table 2).

The control did not present lower values of diameter of stem; the doses responsible for this effect were 10, 20 and 30 t ha^{-1} (Figure 3). This result is confirmed when analyzing the linear coefficients

Table 1. Equation of the analysis of regression of maize plant height in function of doses of organic and chemical fertilization

Fertilization	Equation	R^2
Cattle manure 0 t ha^{-1}	$y = 9.135 + 1.53^{***} x + 0.0436 x^2$	0.9988
Cattle manure 10 t ha^{-1}	$y = 13.31 + 0.7949^{***} x + 0.0608 x^2$	0.9982
Cattle manure 20 t ha^{-1}	$y = 9.082 + 1.2211^{***} x + 0.0533 x^2$	0.998
Cattle manure 30 t ha^{-1}	$y = 11.785 + 1.0045^{***} x + 0.0557 x^2$	0.9985
Cattle manure 40 t ha^{-1}	$y = 6.434 + 2.0164^{***} x + 0.0416 x^2$	0.9975
Cattle manure 50 t ha^{-1}	$y = 11.173 + 1.0813^{***} x + 0.0573 x^2$	0.9989
Cattle manure 60 t ha^{-1}	$y = 21.94 + 0.3106^{***} x + 0.0657 x^2$	0.9958
500 kg ha^{-1} de 4-14-8+Zn	$y = 10.773 + 1.1211^{***} x + 0.052 x^2$	0.9976

****(p<0.001) highly significant*

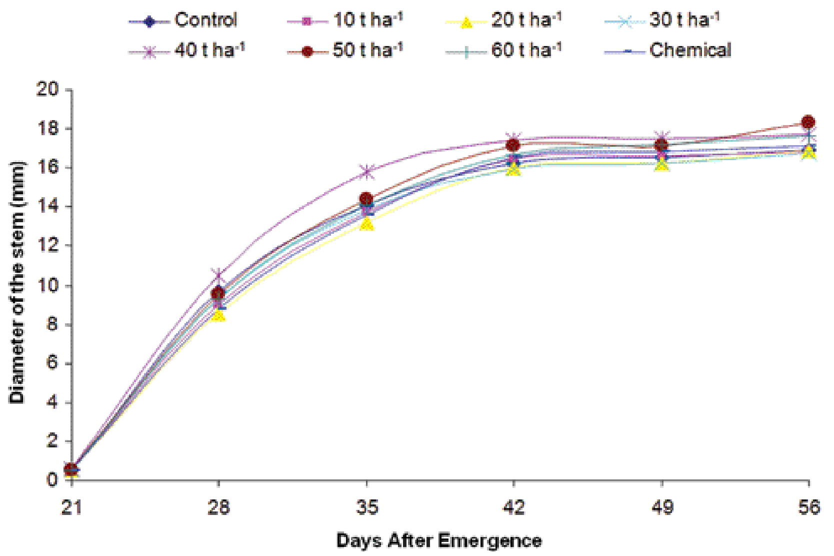

Figure 3. Diameter of the stem of maize plants in function of doses of organic and chemical fertilization.

Table 2. Equation of the analysis of regression of the maize plant diameter in function of doses of organic and chemical fertilization.

Fertilization t ha^{-1}	Equation	R^2
Cattle manure 0 t ha^{-1}	$y = -8.178 + 1.5046^{**} x - 0.022 x^2$	0.9822
Cattle manure 10 t ha^{-1}	$y = -8.488 + 1.503^{***} x - 0.0217 x^2$	0.9911
Cattle manure 20 t ha^{-1}	$y = -8.005 + 1.4176^{***} x - 0.0199 x^2$	0.9909
Cattle manure 30 t ha^{-1}	$y = -8.001 + 1.4648^{**} x - 0.0212 x^2$	0.9825
Cattle manure 40 t ha^{-1}	$y = -9.174 + 1.6853^{**} x - 0.0254 x^2$	0.9775
Cattle manure 50 t ha^{-1}	$y = -8.403 + 1.5177^{***} x - 0.0215 x^2$	0.9841
Cattle manure 60 t ha^{-1}	$y = -8.389 + 1.5036^{***} x - 0.0214 x^2$	0.9902
500 kg ha^{-1} de 4-14-8+Zn	$y = -8.458 + 1.4848^{***} x - 0.0211 x^2$	0.9935

***(0,01>p≥0,001) highly significant; ***(p<0,001) very highly significant.*

of the equation in Table 2, which in the treatments cited above and in 60 t ha^{-1}, are those which present lower daily increment.

In Figure 4, there is the number of maize plant leaves evaluated weekly, from the third week.

The dose of 40 t ha^{-1} provided a higher initial number of leaves (Figure 4), this is due to the interception of the equation, where it presented higher values in relation to the other treatments (Table 3).

The chemical fertilization, the control and the doses 20 and 10 t ha^{-1} contributed to the lower number of leaves (Figure 4). It is important to emphasize that not always the higher number of leaves is required, mainly when it is considered the shading. The number of leaves higher infiltration of sunlight in the canopy, even with high index of leaf area (ARGENTA et al., 2001), maximizing the photosynthetic efficiency.

The analysis of variance for the characteristics related to the tassel and to the leaf can be found in Table 4. It was detected significant difference only for the leaf area.

In the Table 5 it can be verified the non-significant effect of the characteristics: number of ramifications of the tassel, angle of tassel, length of

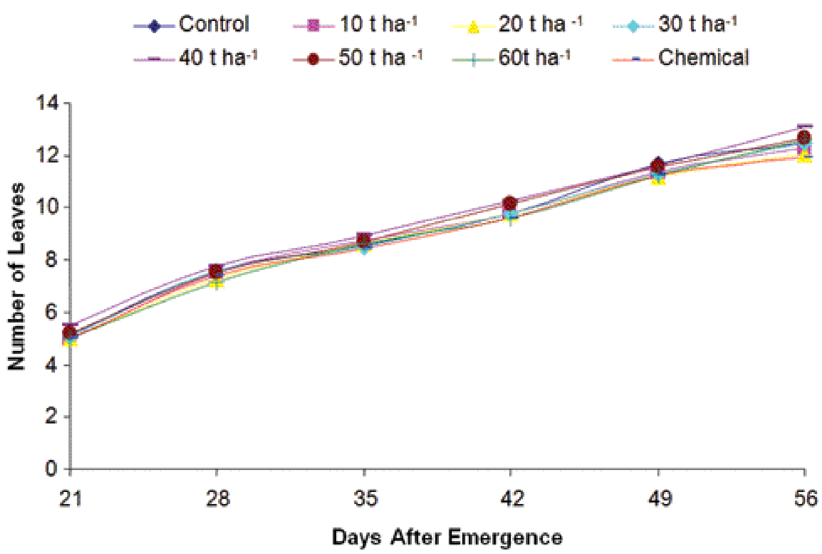

Figure 4. Number of leaves per maize plant in function of doses of organic and chemical fertilization.

Table 3. Equation of the analysis of regression of number of leaves of the maize plants in function of doses of organic and chemical fertilization.

Fertilization	Equation	R^2
Cattle manure 0 t ha^{-1}	$y = 3.401 + 0.2879^{**} x - 0.0017 x^2$	0.9864
Cattle manure 10 t ha^{-1}	$y = 3.099 + 0.3178^{**} x - 0.0024 x^2$	0.9889
Cattle manure 20 t ha^{-1}	$y = 3.117 + 0.311^{***} x - 0.0024 x^2$	0.9954
Cattle manure 30 t ha^{-1}	$y = 3.498 + 0.2747^{**} x - 0.0015 x^2$	0.9886
Cattle manure 40 t ha^{-1}	$y = 3.962 + 0.2608^{***} x - 0.0011 x^2$	0.9937
Cattle manure 50 t ha^{-1}	$y = 3.291 + 0.3042^{***} x - 0.002 x^2$	0.9955
Cattle manure 60 t ha^{-1}	$y = 3.388 + 0.2658^{***} x - 0.0012 x^2$	0.9943
500 kg ha^{-1} de 4-14-8+Zn	$y = 3.22 + 0.2986^{***} x - 0.0022 x^2$	0.9901

*** (0.01>p≥0.001) highly significant; ***(p<0.001) very highly significant.*

Table 4. Decomposition of the analysis of variance for the characteristics related to the tassel and the leaf, in function of doses of organic and chemical fertilization in Latossolo Vermelho-Amarelo Distrófico típico.

Source of variation	GL	Mean Square					
		Tassel ramification	Tassel angle	Tassel length	N° of leaves above the 1st ear	Angle of 3rd leaf	Leaf area
Doses	7	4.623^{NS}	116.110^{NS}	8.499^{NS}	0.485^{NS}	86.12^{NS}	14247.627**
Waste	232	6.692	241.758	20.617	6.615	114.552	6991.671
C.V. (%)		35.3	43.42	8.35	13.72	19.82	17.95
DMS		0.472	3.66	1.070	0.143	2.522	15.266

***significant at 1% of probability by the F test.*
NS – non significant by the F test.

tassel, number of leaves above the first ear and angle of third leaf.

In the characteristic leaf area (Table 5), it was verified a significant difference between the treatments. The doses which provided the best effect over the leaf area were 20, 40 and 60 t ha^{-1}, differing from the doses 10 t ha^{-1}, 30 t ha^{-1}, 50 t ha^{-1}, from the control and the chemical fertilization. In similar work performed with the hybrid maize, CANCELLIER et al. (2010) verified that the higher leaf area of the studied doses without the application of nitrogen was with 40 t ha^{-1} of the organic fertilization, collaborating with the results found.

In order to guarantee the increase of the leaf area, it is important that the water availability in the soil is appropriated, guaranteeing for consequence the satisfactory development and yield by the culture; this guarantee may be obtained by the application of manure concentrate in the seeding row, besides maintaining the soil humidity, it also guarantees the availability of nutrients in the zone of higher concentration of roots.

The leaf area is a characteristic which is strictly related to the grain production. This occurs basically by the larger capacity that the leaves well nourished have to assimilate CO_2 and synthesize carbohydrates during the photosynthesis, resulting in a higher accumulation of biomass. But, this characteristic must be allied to a satisfactory angulation, otherwise it will facilitate the shading, since the maize leaves have the tendency to be more horizontal, harming, thus, the final production.

The analysis of variance of parameters related to the ear and plant height may be observed in Table 6. From all the characteristics evaluated, only the diameter of the ear presented significant interactions between the treatments to which the plants were submitted.

The diameter of the ears (Table 7) reflects the productive capacity of the plant; the higher diameter favors the formation of higher quantity of grains. The doses responsible for the best effect

Table 5. Ramification of the tassel, angle of tassel, length of tassel, number of leaves above the first ear, angle of third leaf and leaf area in function of doses of organic and chemical fertilization applied in a Latossolo Vermelho-Amarelo Distrófico típico in the municipality of Gurupi – TO.

Fertilization	Tassel			Leaf		
	Ramification	Angle (degrees)	Lenght (cm)	Nº Above 1º Ear	Angle 3ª	Leaf area (cm^2)
Catlle manure 0 t ha^{-1}	7.7	37.5	54.08	5.83	55.61	439.82 b
Catlle manure 10 t ha^{-1}	7.7	33.61	54.72	5.63	49.11	466.58 b
Catlle manure 20 t ha^{-1}	6.46	37.22	55.19	5.83	53.11	478.78 a
Catlle manure 30 t ha^{-1}	7.33	32.27	54.22	5.9	54.16	444.37 b
Catlle manure 40 t ha^{-1}	7.53	37.88	55.41	5.56	53.77	502.53 a
Catlle manure 50 t ha^{-1}	7.33	39.22	54.33	5.73	55.72	451.43 b
Catlle manure 60 t ha^{-1}	7.36	33.16	53.83	5.56	55.38	485.51 a
500 kg ha^{-1} de 4-14-8+Zn	7.2	35.61	53.36	5.7	55.11	456.98 b

**Averages followed by the same upper case letter in the column do not differ, by Skott-Knott test, at the level of 5% of probability.*

Table 6. Decomposition of the analysis of variance for the parameters related to the ear and plant height in function of doses of organic and chemical fertilization in Latossolo Vermelho-Amarelo Distrófico típico.

Source of variation	GL	Mean Square					
		Height of ear insertion	Diameter of the ear	Lenght of the ear	Nº Grain Row/ Ear	Nº of Grain/ Row	Plant Height
Doses	7	149.681^{NS}	18.54^{**}	6.994^{NS}	6.222^{NS}	20.911^{NS}	0.122^{NS}
Resíduo	232	123.697	8.91	6.16	3.363	14.654	0.066
C.V. (%)		15.85	6.46	16.85	12.29	13.27	12.39
DMS		2.03	0.703	0.585	0.432	0.902	0.046

**significant at 1% of probability by the F test.
^{NS} – non significant by the F test.

Table 7. Parameters related to the ear and plant height in function of doses of organic and chemical fertilization applied in a Latossolo Vermelho-Amarelo Distrófico típico in the municipality of Gurupi – TO.

Fertilization	Ear					Plant Height (m)
	Insertion Height (cm)	Diameter (mm)	Lenght (cm)	Nº Grain Row/Ear	Nº Grain/ Row	
Cattle manure 0 t ha^{-1}	68.46	44.75 b	14.61	13.66	27.83	2.09
Cattle manure 10 t ha^{-1}	72.8	45.55 b	14.45	15.38	29.72	1.94
Cattle manure 20 t ha^{-1}	73.36	46.95 a	15.96	15.22	30.33	2.14
Cattle manure 30 t ha^{-1}	67.55	45.68 b	14.38	14.55	28.11	2.10
Cattle manure 40 t ha^{-1}	69.06	47.94 a	14.03	15.22	28.61	1.99
Cattle manure 50 t ha^{-1}	68.76	46.34 a	15.12	15.05	30.11	2.03
Cattle manure 60 t ha^{-1}	69.83	46.81 a	15.04	15.44	28.5	2.08
500 kg ha^{-1} de 4-14-8+Zn	72.08	45.55 b	14.23	14.77	27.5	2.06

**Averages followed by the same lowercase letter in the column do not differ, by the Scott-Knott test, at the level of 5% of probability.*

in the diameter were 20, 40, 50 and 60 t ha^{-1}, which differ statistically from the doses 10 t ha^{-1}, 30 t ha^{-1}, control and chemical fertilizer as well as it was verified in the parameter leaf area. Studying different cultivars of hybrid maize under organic fertilization, SANTOS et al. (2005) verified in average the ear diameter of 44.00 mm, values this smaller than the observed (Table 7). However, it can be verified that the length and diameter of the maize ear aim to the increase of the grain weight, since they act indirectly to the increase in the grain weight (FANCELLI and DOURADO-NETO, 1999).

In Table 8 it can be found the decomposition of the analysis of variance for the components of the production. There was no significant difference for the evaluated characteristics, showing that the doses of organic fertilizer (cattle manure) did not influence the decomposition of the studied maize hybrid.

However, in Table 9 it can be observed that for the ear green matter, plant green matter and total green matter, higher value in the doses of 20 and 40 t ha^{-1} of cattle manure. CANCELLIER et al. (2010) observed that the effect in the doses higher than 20 t ha^{-1} of manure in the hybrid maize culture did not differ statistically from the control and chemical, presenting higher values. Maize responds progressively to high fertilization, as long as the other factors are in great levels (ARGENTA et al., 2001).

Conclusions

The organic fertilization influenced significantly in the initial plant height, stem diameter, number of leaves, leaf area and diameter of the ear of the maize culture.

The application of the cattle manure in the planting furrow may substitute the chemical fertilization, without compromising the performance of the culture for the forage production.

Table 8. Decomposition of the analysis of variance for Ear Green Matter (EGM), Plant Green Matter (PGM) in function of doses of organic and chemical fertilization in Latossolo Vermelho-Amarelo Distrófico típico.

Source of variation	GL	Mean Squares		
		PGM	EGM	TGM
Doses	7	4204634.2857^{NS}	1860691.60^{NS}	10795801.31^{NS}
Waste	40	4270830.00	1923574.35	10198566.60
C.V. (%)		16.50	13.94	14.21
DMS		4234.90	2842.11	6544.20

NS – non significant by the Tuckey test.

Table 9. Evaluation of Plant Green Matter (PGM), Ear Green Matter (EGM) and Total Green Matter (TGM) in function of doses of organic and chemic fertilization applied in a Latossolo Vermelho-Amarelo Distrófico típico.

FERTILIZATION	PGM	EGM	TGM
		..........kg ha^{-1}..........	
Cattle manure 0 t ha^{-1}	11712	9462	21174
Cattle manure 10 t ha^{-1}	12000	9857	21857
Cattle manure 20 t ha^{-1}	13600	10844	24444
Cattle manure 30 t ha^{-1}	11056	9116	20172
Cattle manure 40 t ha^{-1}	13648	10778	24426
Cattle manure 50 t ha^{-1}	12452	10092	22544
Cattle manure 60 t ha^{-1}	12604	9912	22516
500 kg ha^{-1} de 4-14-8+Zn	13128	9556	22684

References

ALVES, E. U.; OLIVEIRA, A. P.; BRUNO, R. L. A.; SADER, R.; ALVES, A. U. Rendimento e qualidade fisiológica de sementes de coentro cultivado com adubação orgânica e mineral. **Revista Brasileira de Sementes**. Jaboticabal: vol. 27, n. 1, p. 132-137, 2005.

ARGENTA, G.; SILVA, P. R. F.; SANGOI, L. Arranjo de plantas de milho: análise do estado-da-arte.

Ciência Rural, v. 31, n. 6, p. 1075-1084. 2001.

CANCELLIER, L. L.; AFFÉRRI, F. S.; ADORIAN, G. C.; RODRIGUES, H. V. M. Influência da adubação orgânica na linha de semeadura na emergência e produção forrageira de milho. **Revista Verde**. Mossoró: v. 5, n. 5. p. 25-32, 2010.

FANCELLI, A.L.; DOURADO-NETO, D. **Tecnologia da produção de milho**. Piracicaba: FEALQ/ESALQ/USP, 1999. 360 p.

FERREIRA, D. F. **Programa de análises estatísticas (Statistical Analysis Software) e planejamento de experimentos**. Lavras: UFV, 2003.

FRANCIS, C. A.; RUTGER, J. N.; PALMER, A. F. E. A rapid method for plant leaf área estimation in maize (Zea mays L.). **Crop Science**, n. 9, p.537-539, 1969.

GOMES, J. A.; SCAPIM, C. A.; BRACCINI, A. L.; VIDIGAL FILHO, P. S,; SAGRILO, E.; MORA, F. Adubações orgânica e mineral, produtividade do milho e características físicas e químicas de um Argissolo Vermelho-Amarelo. **Acta Sci. Agron**. Maringá, v. 27, n. 3, p. 521-529, 2005.

HANDAYANTO, E.; GILLER, K. E.; CADISCH, G. Regulating N release from legume tree prunings by mixing residues of different quality. **Soil Bilologi and Biochemistry**. Amsterdam, v. 29, p.1417-1426. 1997.

IBGE. **Instituto brasileiro de geografia e estatística**. Disponível em:< http://www.ibge.gov.br/home/presidencia/noticias/noticia_visualiza.php?id_noticia=1605&id_pagina=1&titulo=Em-abril,-IBGE-preve-safra-recorde-para-2010>. Acesso em: 10 abril. 2010.

INACIO, A. **Commodities Agrícolas**. Sistema FAEP boletim diário. São Paulo: 20 de maio de 2011. Disponível em: <http://www.sistemafaep.org.br/Estatico/BoletimDiario/bol_diario200511.html>. Acesso em: 24 de maio 2011.

KÖPPEN, W. 1948. **Climatologia**: con un estudio de los climas de la tierra. Fondo de Cultura Econômica. México. 479 p.

MICROCAL ORIGIN. **Origin,** Version 6.1. Microcal Software Inc., Northampton. 1995..

MYERS, R. J. K.; PALM, C. A.; CUEVAS, E.; GUNATILLEKE, I. U. N.; BROSSARD, M. The synchronization of nutrient mineralization and plant nutrient demand. In: Woomer, P. L.; SWIFT, M. J. **The biological management of tropical soil fertility**. New York: John Wiley and Sons, 1994, cap. 5, p.81-116.

SANTOS, I. C.; MIRANDA G. V.; MELO, A. V.; MATTOS, R. N.; OLIVEIRA, L. R.; LIMA, J. S.; GALVÃO, J. C. C. Comportamento de cultivares de milho produzidos organicamente e correlações entre características das espigas colhidas no estádio verde. **Revista Brasileira de Milho e Sorgo**, Sete Lagoas, v. 4, n. 1, p. 45-53, 2005.

SILVA, R. G.; GALVÃO, J. C. C.; MIRANDA, G. V.; SILVA, D. G. ARNHOLD, E. Produtividade de milho em diferentes sistemas produtivos. **Revista Verde**, Mossoró, v. 2, n. 2, 2007.

SOUZA, J. L. de. **Agricultura Orgânica** – tecnologias para a produção de alimentos saudáveis. V.1, Domingos Martins: EMCAPA, 179 p., 1998.

VALENTINI, L.; FERREIRA, J. M.; SHIMOYA, A.; COSTA, C. C. S. Adubação orgânica em milho verde no norte fluminense. **In:** 43 Congresso Brasileiro de Olericultura. 2003, Uberlândia. Hortaliças: qualidade e segurança alimentar, 2003.

VENEGAS, V. H. A.; ALVAREZ, G. A. M. Apresentação de equações de regressão e suas interpretações. **Sociedade Brasileira de Ciência do Solo**, Viçosa, v. 28, n. 3, p. 28-32, 2003.